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Research Article

Enhancing the Knowledge and Self-directed Learning Characteristics of Nursing at a University in Southern Thailand Using Flipped Classroom Teaching Approach

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Abstract

The flipped classroom model is increasingly being adopted in education to enhance students' knowledge and self-directed learning characteristics. However, its implementation in Thai nursing education remains challenging due to several factors, particularly students' passive learning characteristics, limitations of online platforms, and the available learning media tools. Therefore, this study was conducted to examine the effects of the flipped classroom teaching approach on knowledge and self-directed learning characteristics among second-year nursing students in an orthopedic nursing class within the Adults and Elderly Nursing Course 1. A one-group pretest and posttest design was conducted over seven hours of teaching orthopedic nursing content using the flipped classroom approach across multiple days among 166 second year nursing students at a university in the southern part of Thailand. Scores were obtained from pretest, posttest and final examinations and analysed through descriptive statistics and dependent t-test statistics. The results show that over half of participants (n = 99, 59.6%) obtained final examination scores at or above the pass mark of 50%, with no significant differences between pretest and posttest scores ($p > .05$). However, the scores for self-directed learning characteristics related to self-concept in learning efficiency ($p < .05$) and optimistic prospect were increased with significant differences ($p < .001$). In conclusion, the flipped classroom approach did not significantly improve knowledge outcomes but enhanced nursing students' self-directed learning characteristics. These findings suggest that the flipped classroom may be helpful in promoting learner autonomy and active learning in Thai nursing education.

Keywords: Adult and Elderly Nursing Course, Flipped Classroom, Nursing Students, Orthopedic Nursing Class, Self-Directed Learning

Introduction

Active learning currently seems important for enhancing learners' knowledge and ability to adapt themselves in solving problems, and applying their knowledge obtained from the classroom into real situations (Fornari & Poznanski, 2021). Recent studies indicate that the flipped classroom approach is one of the active learning approaches being increasingly implemented in undergraduate nursing education, showing positive impacts on student's academic performance, attitudes satisfaction, self-efficacy, and self-directing learning characteristics (Banks & Kay, 2022; Chikeme et al., 2024). To effectively implement the flipped classroom strategy, the flipped classroom is mostly designed as a hybrid teaching approach, combining online learning and face-to-face activities in the classroom (Lee & Martin, 2020). Additionally, learners are required to engage in reviewing and exploring learning materials before attending class (Ng, 2023). This pre-class learning helps them grasp key concepts prior to being able to construct, apply, and solidify knowledge while participating in class activities, thereby improving their skills for critical thinking and self-directed learning characteristics (Banks & Kay, 2022).

Various studies confirmed that flipped classroom approach enhances self-directing learning characteristics among nursing students (Fan et al., 2020; Khodaei et al., 2022; Yao et al., 2023), which is associated with learning achievement and life-long learning (Chen & Fan, 2023). Self-directed learning characteristics are classified into eight characteristics, including 1) openness to learning opportunities, 2) self-concept in learning efficiency, 3) initiative and independence in learning, 4) responsibility for own learning, 5) love of learning, 6) creativity, 7) positive orientation of the future, and 8) ability to use self-inquiry and problem solving skills (Paiwithayasiritham, 2013). Self-directed learners, therefore, are those who can diagnose their own learning needs, set goals, identify resources, choose and implement appropriate learning strategies, evaluate outcomes, and take responsibility for their own learning (Anshu et al., 2022). Developing self-directing learning characteristics is crucial for students to foster independence, accountability, responsibility, assertiveness, and essential qualities throughout their nursing career, enabling them to broaden their theoretical knowledge and increase the quality of clinical nursing practice (Vasli & Asadiparvar-Masouleh, 2024).

Game-based learning and case-based learning have been identified as beneficial strategies in nursing education for improving students' critical thinking and problem-solving skills (Borit & Stangvaltaite-Mouhat, 2020; Xu et al., 2024). Game-based learning can be used to enhance student engagement, increase their concentration and enjoyment of learning, thereby stimulating motivation and improving students problem-solving skills (Borit & Stangvaltaite-Mouhat, 2020). Case based-learning is often integrated into the flipped classroom approach where students are required to engage in self-directing learning to understand materials, discuss clinical cases and develop solutions (Xu et al., 2024). Using case based-learning in flipped classroom had positive effects on curriculum grades and self-directing learning, as well as led to higher retention of knowledge and fostered better critical thinking skills (Pinzur, 2019). Combining case based-learning with the flipped classroom approach, group learning and online learning environment are keys to providing an interactive space where teachers can guide students towards deeper and more participatory application of basic concepts and subjects (Xu et al., 2024). Additionally, designing classes that integrate multiple activities can encourage students to ask questions, facilitate knowledge sharing between students and instructors, and enhance the application of classroom knowledge to clinical practice (Reidsema et al., 2017; Smith, 2017). Thus, using appropriate technology and online platforms can facilitate effective learning strategies both pre- and post-classroom sessions, as well as to encourage interaction between group learners and teachers.

Using technology in teaching and learning strategies for learners who are in Generation Z also plays a key role (Chunta et al., 2021). Generation Z learners, including Thai students, are familiar with learning in an environment full of continuous technological advancement and value autonomy. They are also more motivated to engage in learning when activities are meaningful and provide opportunities for experiential, hands-on learning. Therefore, teaching-learning design methods and approaches must be appropriately facilitated to support their

learning needs (Chicca & Shellenbarger, 2018). Currently, the flipped classroom approach is widely used to stimulate Generation Z learners, as it enables students to learn at their own pace and demonstrate their performance individually through the completion of individual and/or group assignments. In addition, this approach promotes flexible learning that aligns with students' available time and learning schedules (Alvarado et al., 2020; Tieu, 2022). Most flipped classroom approaches incorporate online pre-class learning to allow learners to engage with the content through pre-recorded lectures, such as interactive videos or narrated PowerPoint slides, followed by in-class activities focused on evaluation, discussion, addressing questions, and clarifying misunderstandings (Barranquero-Herbosa et al., 2022; Khodaei et al., 2022; Yao et al., 2023). Similarly, Lee & Martin (2020) highlighted that online learning in flipped classroom to deliver instructional content through media, for example videos or other out-of-class activities can enable students to review content independently until they are confident and have a solid understanding of the content. Whereas, in class content learning always focuses on higher-order critical thinking skills according to Bloom's Taxonomy level (Lee & Martin, 2020). Consequently, using flipped classroom approach is beneficial for engaging Generation Z learners in academic learning courses, enhancing their learning outcome achievement and developing critical skills required to apply knowledge effectively in practice.

Despite the recognised benefits of the flipped classroom approach, its adoption remains challenging due to students' passive learning characteristics and limitations of online platforms. Additional constraints relate to learning media tools, including limited internet accessibility, poor video quality, and the lack of interactive video features that support active student engagement during viewing (Alvarado et al., 2020; Mukpradab et al., 2018). In our previous study, which implemented and tested the flipped classroom over seven hours of classroom activities with second year nursing students for the orthopedic nursing care topic of Adult and Elderly Course 1 during the academic year 2017-2018, improved learning outcomes and self-directing learning characteristics were found (Mukpradab et al., 2018). However, several barriers affected the learning activities. For instance, students faced a high workload from other courses, which limited their time to complete pre-class activities and contributed to learning burnout. In addition, there was duplication of content between pre-class activities and in-class session, and the online video lessons were lengthy with limited interactivity, resulting primarily in passive content viewing. (Mukpradab et al., 2018). To address these challenges, we redesigned implementation strategies to more effectively employ the flipped classroom approach for teaching orthopedic nursing care to second-year nursing students, with a primary emphasis on online learning rather than in-class activities. The redesigned approach consisted of four hours of online learning to support self-learning and collaborative learning through short online video lessons with increased interactivity (15-20 minutes) and case-based learning prior to three hours in-class sessions, which focused on summarising key concepts through game-based learning. It was anticipated that this redesigned approach would provide students with greater flexibility to manage their time alongside existing academic workloads, thereby enhancing their engagement in learning orthopedic nursing care. However, evidence on the effectiveness of flipped classroom approach that are predominantly delivered through online learning rather than in-class activities remains limited within Thai nursing education. Therefore, this study aimed to explore the learning outcomes and self-directed learning characteristics of the second-year nursing students after the implementation of the redesigned flipped classroom approach in orthopedic nursing class within the Adults and Elderly Nursing Course 1.

Research Objectives

The purpose of this study was to examine the effects of the flipped classroom teaching approach on knowledge and self-directed learning characteristics among second-year nursing students in an orthopedic nursing class within the Adults and Elderly Nursing Course 1

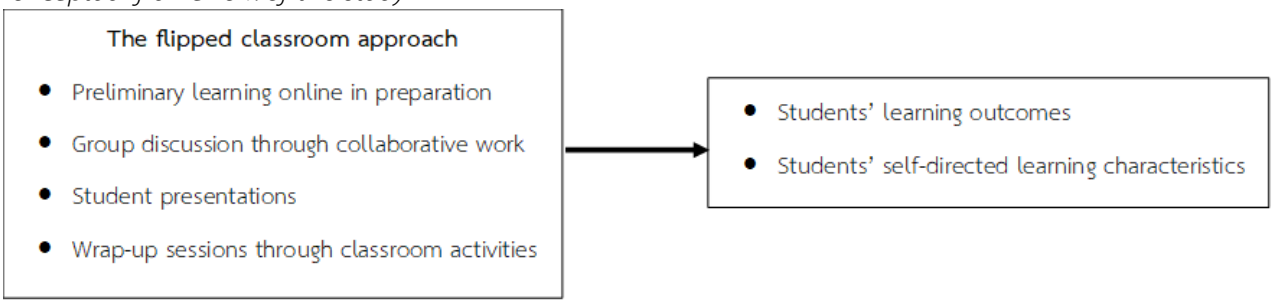
Conceptual framework

The conceptual framework of this study was underpinned by the flipped classroom approach to improve learning outcomes and transition student roles from passive learners to active learners (Reidsema et al., 2017). The flipped classroom design is recognised as an active learning method with a student-centred approach which

enhances important skills for life-long learning, especially student-led learning, critical thinking, and self-directed learning characteristics. These skills are fostered through various class activities, such as preliminary learning online in preparation, group discussion through collaborative work, student presentations, and wrap-up sessions that summarise key concepts of knowledge through classroom activities (Reidsema et al., 2017; Smith, 2017). Therefore, the flipped classroom approach was applied in orthopedic class to teach nursing students over a seven-hour period, with a primary focus on improving nursing students' learning outcomes and self-directed learning characteristics through both online learning and classroom-based activities. The conceptual framework of this study is shown in Figure 1.

Figure 1

Conceptual framework of this study



Methodology

1. Research design

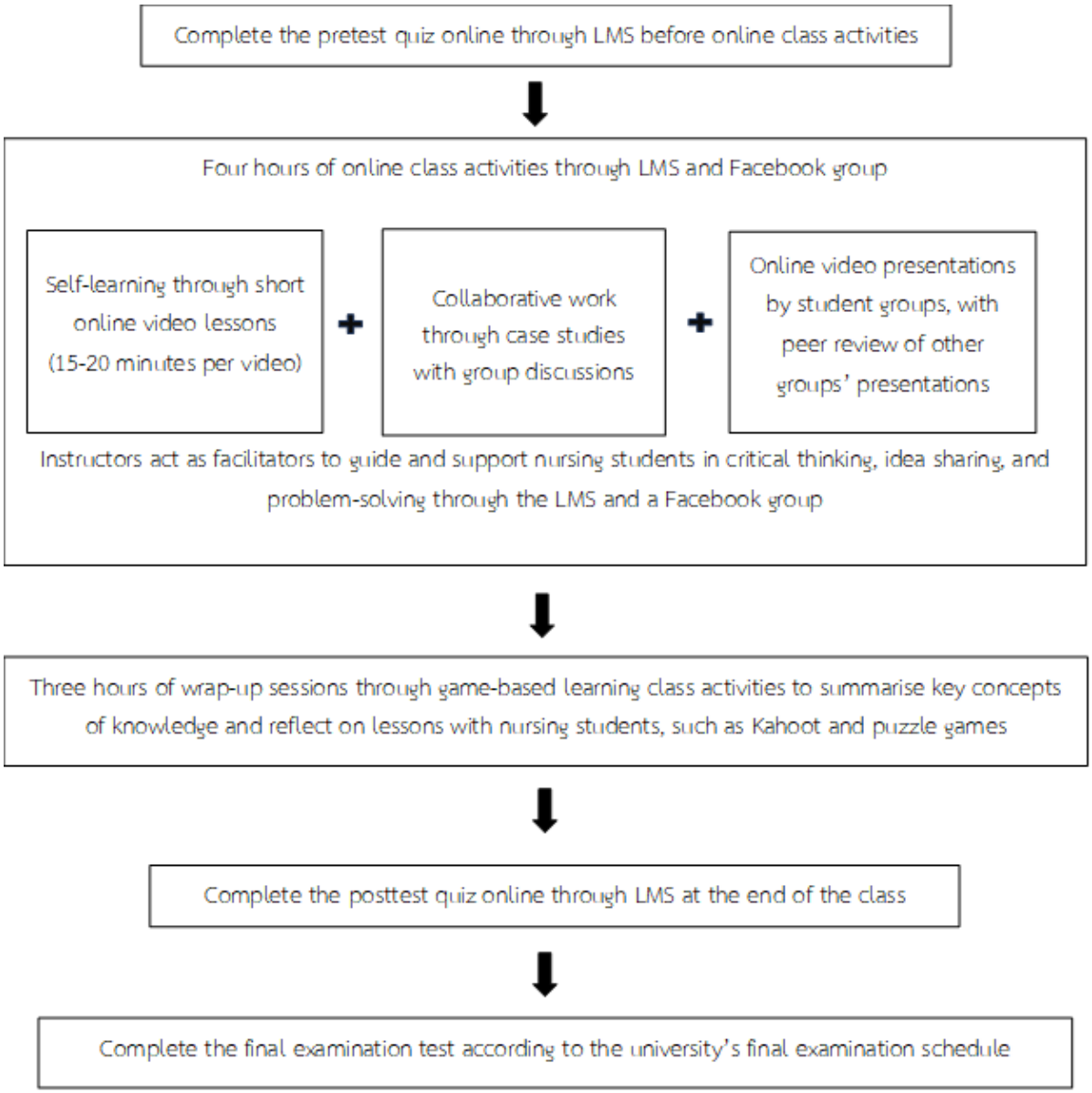
A one-group pre-posttest design was undertaken to examine learning outcomes and self-directed learning characteristics after using flipped classroom in the orthopedic class.

2. Flipped classroom activities

The orthopedic class used the flipped classroom approach through seven hours across multiple days which included four hours for online activities and three hours for game-based learning class session. Prior to the online class activities, all students completed a pretest quiz online through LMS. The first four of seven hours in orthopedic class were specifically allocated to support nursing students' self-preparation and self-directed learning through online learning media tools. The online learning media tools involved short online video lessons (15- 20 minutes per video), case studies with group discussions, and student online video presentations for applying orthopedic nursing care in case studies. All these activities were conducted through LMS and Facebook group. Throughout the preparation and self-directed online learning phases, instructors played the roles of facilitators, guiding and assisting nursing students in critical thinking, idea sharing, and problem-solving through LMS and Facebook group. After the online learning class activities, instructors dedicated three hours to summarising and reflecting on all lessons with nursing students through various class activities, including Kahoot and puzzle games. These activities were designed to stimulate students' inquiries, promote interaction and knowledge sharing with instructors, and support the practical application of classroom knowledge to clinical practice through case-based learning. Then, all students completed a posttest quiz online at the end of the class and subsequently took the final examination test according to the university's final examination schedule. The flipped classroom activities in this study are shown in Figure 2.

Figure 2

Flipped classroom activities in this study



3. Population and sample

The population of this study was nursing students at a university in the southern part of Thailand, and participants were recruited using purposive sampling. Students were eligible to participate if they met the inclusion criteria, including being in their second year and enrolled in the Adults and Elderly Nursing Course 1. Thus, the sample of this study comprised all 166 second year nursing students.

4. Research instruments

4.1 Teaching Instruments

4.1.1 A flipped classroom lesson plan

A seven-hour lesson plan for a flipped classroom was developed by the instructor team to guide the team in teaching orthopedic nursing care to second-year nursing students over seven-hour across multiple days. The lesson plan covered orthopedic topics, such as orthopedic nursing care concepts and assessment, along with case studies on nursing care for femur fractures, lumbar spondylolisthesis with surgical treatment, arthritis,

and osteoarthritis with joint replacement surgery. The seven-hour lesson plan underwent a thorough review and discussion among the instructor team to confirm accuracy and validate its content.

4.1.2 Online learning media tools

Online learning media tools were developed by the instructor team, consisting of short online video lessons (15-20 minutes); Facebook group for online learning orthopedic nursing care; online class for orthopedic nursing care in LMS; and power point presentations. Game-based learning platforms, such as Kahoot and puzzle games, were also created to motivate nursing students to actively participate and share their ideas during class activities. All these tools were reviewed and discussed among the instructor team to confirm content accuracy and validity.

4.1.3 Clinical teaching equipment

Specific equipment for orthopedic nursing care was prepared and utilised to support nursing students in self-learning and self-application for orthopedic nursing care practices. The specific equipment used included walker, lumbar support, cane, cervical collar, patient bed, pillow, wheelchair, and blanket.

4.1.4 Case studies

Four case studies were developed by the instructor team. These case studies included nursing care for pre and post operations of: (1) fractured femur with Open Reduction Internal Fixation (ORIF) surgery, (2) herniated nucleus pulposus with spine operation, (3) total knee arthroplasty, and (4) hip arthroplasty. The contents of all case studies were reviewed by the instructor team who had experience and were experts in orthopedic nursing care until consensus was reached to confirm the accuracy of the contents

4.2 Outcome instruments

4.2.1 Pretest and posttest quizzes

The instructor team developed pretest and posttest quizzes which consisted of the same 20 true-false questions and covered a seven-hour topic on orthopedic nursing topic. The order of the questions was randomized between the pretest and posttest to reduce recall bias. The content validity of pretest and posttest questions were determined by the instructor team, who were experts in orthopedic nursing care. The pretest and posttest quizzes were completed before the start of the class and at the end of the class, respectively. The reliability was evaluated using Cronbach's alpha, which yielded a value of 0.70, indicating an acceptable internal consistency for use in this study (Polit, 2014).

4.2.2 Final examination test

The instructor team developed thirty-five multiple-choice questions for the final examination test related to orthopedic nursing care and this test was used to assess students' learning outcomes according to the university's final exam schedule. The final examination test underwent a thorough review and discussion by the instructor team, as well as among other instructors who taught the Adults and Elderly Nursing Course 1. This was to establish both content validity and quality of item questions seeking good values of difficulty indices (ranging from 0.27 to 0.74) and discrimination index (ranging from 0.20 to 0.63). The total final examination test scores on the topic of orthopedic nursing care were 35 with a range of 0 to 35. In this study, we expected that nursing students should obtain the final examination test scores equal to or higher of 50%, corresponding to a score of 18 or above, as this was the passing mark set for the lecture classes in the bachelor's program.

4.2.3 Self-directed learning characteristics questionnaire

The self-directed learning characteristics questionnaire was initially developed by Chareonchim et al. (2012) and subsequently revised by Kritpracha et al. (2018) for measuring self-directed learning characteristics. The self-directed learning characteristics questionnaire consisted of 50 items across eight subscales, including (i) educational opportunities (Item 1-5), (ii) self-concept in learning efficiency (Item 6-12), (iii) learning independence skills (Item 13-17), (iv) responsibilities for learning (Item 18-26), (v) love of learning (Item 27-31), (vi) creative thinking (Item 32-37), (vii) optimistic prospect (Item 38-42), and (viii) self-inquiry and problem solving (Item 43-50). All items were measured on a five-point Likert scale, ranging from 1 (least true for you) to 5 (absolutely true for you).

The overall total score on the questionnaire ranged from one to 250, with higher scores indicating greater self-directed learning characteristics (Kritpracha et al., 2018). The self-directed learning characteristics questionnaire demonstrates a good internal consistency reliability as reflected by a Cronbach's alpha coefficient of 0.96 (Kritpracha et al., 2018).

5. Data collection

The flipped classroom was implemented for teaching nursing students in orthopedic nursing care during a seven-hour class. Prior to the session, participants were asked to complete the online pretest and self-directed learning characteristics questionnaire. Then, participants spent four hours for self-learning through participating in online learning lessons that were in Facebook orthopedic nursing care group and LMS. Participants also self-managed to spend these four hours in group discussion (fourteen people per group) for critical thinking and applying the lessons for orthopedic nursing care through using case studies, as well as applying the use of specific equipment for supporting nursing care in each case study. The specific equipment for orthopedic nursing care consisted of walker, lumbar support, cane, cervical collar, patient bed, pillow, and wheelchair.

Additionally, participants presented and shared their video projects relating to orthopedic nursing care in case studies through Facebook orthopedic care group which allowed all participants to watch and discuss them along with the instructor team. During the preparation and self-directed online learning phases, the instructor team served as facilitators in guiding and encouraging all participants in critical thinking and idea-sharing throughout learning online as well as providing suggestions for accuracy of their work. Following the online learning, the instructor team dedicated three hours to summarize key concepts and reflect on all lessons with all participants through class activities. In the class activities, game-based learning platforms, including Kahoot and puzzle games, were used to summarise key concepts from all lessons and encourage all participants to share and discuss ideas for translating knowledge into nursing orthopedic care practice. Finally, all participants were asked to complete the online posttest and the self-directed learning characteristics questionnaire at the end of the class, and subsequently took the final examination test on the date specified in the university's examination schedule.

6. Data analysis

Data were entered into IBM SPSS Statistics for Window, Version 26 (IBM Corp, 2019), and subsequently checked and cleaned by identifying the value codes, variable names, and missing data. A zero-rate entry error was identified and no data imputation methods were applied due to minimal missing data, which were less than 10% for individual items (Bennett, 2001). Descriptive statistics were used for data analysis, where mean and standard deviations were analysed for normally distributed continuous data (Polit, 2014). Frequency distributions and percentages were calculated for categorical data (Polit, 2014). For the comparison, dependent t-test was analysed to examine the differences in students' learning outcomes and self-directed learning characteristics before and after participating in the flipped classroom (Field, 2009). Wilcoxon signed-rank test was also employed when the data were not normally distributed (Field, 2009).

7. Research ethics

This study was approved by the Institutional Research Board of the Faculty of Nursing, Prince of Songkla University, Thailand (PSU IRB 2018-NL 005). All participants were informed of the study purpose and that they could withdraw from the study at any time without any effect on their study. A participant code was also used to ensure privacy protection and confidentiality of information.

Results

1. Participants' characteristics

All 166 participants completed pretest, posttest, the final examination test, and the self-directed learning characteristics. The participants' characteristics are shown in Table 1. Most participants were female and identified themselves as Buddhists. The mean Grade Point Average (GPA) was 3.13 (*SD* = 0.33), with most participants falling

within the GPA range of 3.01 to 3.50. Most participants reported using smartphones, spending over two hours on the internet usage, and frequently using the internet for information searches.

Table 1

Participants' characteristics (N = 166)

Variables	n (%)
Gender	
Male	8 (4.8%)
Female	158 (95.2%)
Religion	
Buddhism	119 (71.7%)
Islam	44 (26.5%)
Christianity	3 (1.8%)
Grade Point Average (GPA) (*M* = 3.13, *SD* = 0.33)	
< 2.50	7 (4.2%)
2.50-3.00	49 (29.5%)
3.01-3.50	89 (53.6%)
3.51-4.00	21 (12.7%)
Using smartphone	
Yes	164 (98.8%)
No	2 (1.2%)
Using internet	
< 1 hour	1 (0.6%)
1-2 hours	9 (5.4%)
>2 hours	156 (94.0%)
Information searches	
Read a book	25 (15.1%)
Ask friends	7 (4.2%)
Use internet (e.g. google, Facebook, or Instagram)	134 (80.7%)

2. Learning outcomes

Students' learning outcomes were measured through pretest, posttest, and the final examination test scores. As reported in Table 2, there was no significant difference between pretest and posttest scores among nursing students after attending flipped classroom in orthopedic class ($p > .05$). However, it was noteworthy that a majority of participants (n = 99, 59.6%) achieved final examination scores equal to or exceeding 50% in the orthopedic nursing care topic (see Table 3).

Table 2

The differences in pretest and posttest scores among second-year nursing students before and after participating in the flipped classroom (N = 166)

Pre-posttest scores	*Median* (IQR)	Z^a	p-value
Pretest	10.0 (0.0)	0.000	1.000
Posttest	10.0 (0.0)		

Note. [a] = Wilcoxon signed-rank test

Table 3

Descriptive statistics for the final examination scores in orthopedic nursing care among second year nursing students (N = 166)

Scores	n(%)	Minimum score	Maximum score	*M(SD)*
		7.0	28.0	18.5 (4.3)
Less than 18	67 (40.4%)			
Equal or more than 18	99 (59.6%)			

3. Self-directed learning characteristics

The self-directed learning characteristics scores of second year nursing students were reported in Table 4. We found that the overall total scores for self-directed learning characteristics among second year nursing students did not show a statistically significant difference before and after participation in the flipped classroom. However, there was a significant increase in scores for self-directed learning characteristics related to self-concept in learning efficiency (p = .013) and optimistic prospect (p = .000) among second year nursing students after attending flipped classroom, compared to their scores before attending the class. These findings indicate that while the overall self-directed learning characteristics remained stable, the flipped classroom positively influenced students' confidence in their learning capabilities and their outlook on learning with small effect size.

Table 4

The differences in self-directed learning characteristic scores among second-year nursing students before and after participating in the flipped classroom (N = 166)

Self-directed characteristic scores	Before attending flipped classroom	After attending flipped classroom	Statistics *(p)*	Effect size (Cohen's d)
	M (SD)	*M (SD)*		
Overall total score	187.44 (20.18)	189.82 (19.94)	1.468 (.144)	0.12
Educational opportunities	4.15 (0.48)	4.12 (0.45)	0.568 (.571)	0.04
Self-concept in learning efficiency	3.63 (0.51)	3.73 (0.51)	-2.524 (.013)*	0.20
Learning independence skills	3.40 (0.48)	3.38 (0.55)	0.348 (.728)	0.03
Responsibilities for learning	3.85 (0.47)	3.90 (0.45)	-1.247 (.214)	0.10
Love of learning	3.26 (0.54)	3.28 (0.58)	-.366 (.715)	0.03
Creative thinking	3.74 (0.47)	3.74 (0.51)	-.232 (.817)	0.02
Optimistic prospect	4.08 (0.60)	4.23 (0.51)	-3.577(<.001)*	0.28
Self-inquiry and problem solving	3.86 (0.51)	3.92 (0.48)	-1.660 (.099)	0.13

Note: *Statistical significance (p < .05)

Discussion

In this study, most nursing students demonstrated success in their learning, with the final examination scores equal to and higher than 50%. Additionally, there was a statistically significant improvement in the scores for self-directed learning characteristics related to self-concept in learning efficiency and optimistic prospect after using the flipped classroom approach. According to a systematic review on the effectiveness of flipped classroom strategy on student performance, it emphasised that the flipped classroom approach enhances self-directed leaning characteristics by providing students' opportunities for collaborative work, idea discussion, problem-solving, and interaction with the instructors, compared to traditional teaching approach (Naik, 2023). As a result of these opportunities, a positive effect on students' learning outcomes was also improved after using the flipped classroom

approach (Zheng et al., 2020). Despite the improvement in self-directed learning characteristics, this study found no significant change in nursing students' pretest and posttest scores after participating in the flipped classroom for the orthopedic class. A possible explanation for this finding may be the quality of the pretest and posttest quizzes, which might have been relatively easy for students because the quizzes were designed as true-false questions. While true-false questions are simple to complete and score, the questions may not fully assess higher-order thinking skills. As a result, students may achieve similar scores on the pretest and posttest quizzes without necessarily demonstrating significant improvement in their understanding or ability to apply orthopedic nursing concepts. Some students may also have scored well based on memorisation or familiarity with the exam format rather than on analytical or problem-solving skills. Therefore, it is recommended that the flipped classroom approach can be used to facilitate the development of self-directed learning characteristics, while quizzes should be designed in multiple formats to enhance assessment quality and better capture students' ability to apply knowledge, ultimately supporting successful learning outcomes.

The scores for self-directed learning characteristics related to self-concept in learning efficiency and optimistic prospect also increased after implementing the flipped classroom approach in orthopedic class in Adults and Elderly Nursing Course 1. This finding is consistent with a case study that examined students' self-directed learning characteristics after using the flipped classroom, which found a significant improvement in students' self-directed learning characteristics (Zainuddin & Perera, 2018). When considering the strategies used in the flipped classroom approach, providing lecture materials online allowed students' opportunity to review the materials as needed until they understood the learning concept. Accessing the lecture materials online also helped the students prepare themselves well before attending class activities, thereby enhancing their confidence in discussing ideas during class activities in face-to-face sessions (Zainuddin & Perera, 2018). Furthermore, the flipped classroom increased the interaction between students and instructors through discussion and individualised feedback on assignments via various activities both in class and online sessions, such as pretest, group-based case studies, and game-based learning activities (Zainuddin & Perera, 2018). As a result of these strategies, not only did the students feel more confident in their learning abilities but they also developed daily learning habits, thereby enhancing their self-directed learning characteristics especially self-concept in learning efficiency and optimistic prospect.

Although more than half of participants (n = 99, 59.6%) had the final examination score equal to or more than 50%, this percentage was lower when compared to our previous study (Mukpradab et al., 2018). When we considered a flipped classroom lesson plan in our current study, online activities were incorporated for teaching nursing students during a four-hour orthopedic class. These online activities were used in both the self-preparation phase and group work for case-based learning, including nursing care for fractured femur, herniated nucleus pulposus with pre and post spine operation, arthritis, osteoarthritis with pre and post operation for total knee arthroplasty and hip arthroplasty. In contrast, our previous study only used online activities for self-preparation, including completing pretest and posttest quizzes, and watching online learning video before participating in class activities. All students also needed to participate in individual and collaborative activities throughout the seven hours of orthopedic class (Mukpradab et al., 2018), potentially providing more structured guidance than three hours class activities for summarising knowledge concepts in our current study. This aligns with previous research indicating that the use of online activities does not guarantee that it facilitates motivating students in achieving their learning goals or improving their learning outcomes, as the effectiveness of using online activities depends on individual student characteristics (Imsa-ard, 2020). Furthermore, some students have passive learning behaviors, which can impact their learning outcomes in active learning environments using online activities (Surakarn et al., 2020). For instance, academically stronger students tended to succeed in achieving their learning goals because they could manage their time for self-preparing and learning through attending online activities, whereas some students might struggle due to a lack of this ability, requiring more time for self-preparing and learning (Surakarn et al., 2020). Consequently, while integrating online activities in a flipped classroom can enhance engagement and support active learning, their effectiveness in improving student performance and motivation depends on students'

individual characteristics, highlighting the need for additional guidance and tailored support to optimise learning outcomes. The instruction team should also consider and add more implementing strategies to enhance student motivation and their active participation in online learning activities (Imsa-ard, 2020; Surakarn et al., 2020).

Facebook platform can be used to support courses designed for active learning. In this study, the LMS platform was used for students to complete pretest and posttest quizzes due to its built-in quiz feature, while the Facebook platform was used to encourage and monitor nursing students' participation in all activities during a seven-hour orthopedic class. The Facebook platform was chosen because students frequently use it to access daily news and share daily updates, making it a convenient daily platform for course engagement. Additionally, the Facebook platform supported live streaming and recording of class activities, enabling students to independently review lessons after class until they felt confident in their knowledge related to orthopedic nursing care. When we used Facebook platform, we observed that most nursing students accessed it promptly and actively engaged in up-to-date activities such as watching videos, submitting their video presentations, and sharing their ideas with friends and the instructor team. Moreover, the Facebook platform facilitated interaction between students and teachers through posting up-to-date information and medical technology for orthopedic nursing care, as well as discussion through quick comments on posts and student work. This is consistent with a participatory action research conducted by Awidi et al. (2019), which explored students' perceptions of using Facebook group in a higher education course. The study reported that over half of students expressed satisfaction with the Facebook group activities because it was an easy way to access the lessons, and the posts helped to encourage their engagement in sharing ideas and submitting their assignment on time (Awidi et al., 2019). Moreover, the use of Facebook group helped their comprehension of lessons which contributed their positive perceptions and learning experiences in active learning environment (Awidi et al., 2019). Consequently, the Facebook platform could be a useful tool for teaching and learning, encouraging students to develop self-learning abilities and achieve a deeper understanding of lessons, thereby improving their learning outcomes.

Although this study supports the use of the flipped classroom approach, some limitations were identified in this study. First, there were occasions of delayed internet signals, which could have potentially interrupted the participants' access to short online learning videos. Second, there were many courses that required participants to attend courses at the same period, such as the nursing practice course in hospital settings. These limitations might have impacted participants' ability to engage in activities required of the flipped classroom. Third, our study was conducted on a single site which might limit generalisability. Fourth, although the flipped classroom improved self-directed learning characteristics, particularly self-concept in learning efficiency and optimistic outlook, the effect size was small with Cohen's $d < 0.20$ (Cohen, 1992), suggesting that the magnitude of improvement may be modest due to a small sample size. Consequently, these limitations may have potentially introduced bias in reporting the results of this study.

Conclusions

The use of a flipped classroom can facilitate self-directed student learning by enhancing their ability in self-directed learning characteristics and achieving learning outcomes. The flipped classroom design in this study, especially online class activities, may serve as a guide for developing classrooms to transform students' abilities from passive learners to active learners. At the same time, face-to-face classroom activities should be integrated to ensure students' comprehensive understanding of knowledge through feedback and summarisation of key concepts of knowledge, thereby enhancing overall learning outcomes. Additionally, future research should explore adaptations of the flipped classroom in other subject areas, academic year, and educational settings with larger sample sizes to further validated its effectiveness, increase effect size, and improve generalisability.

Recommendations

Recommendations for application

1. Because students may have multiple assignments from other courses, lecturers should design activities that do not excessively burden students, as this could lead to burnout and may result in their reluctance to participate in the flipped classroom sessions

2. Strategies such as online gamification, should be integrated to increase students' motivation and enhance their comprehensive understanding in participating online learning class, which may foster their development as active learners and improve their learning outcomes.

3. Lecturers should integrate microlearning by dividing online content into short sessions, interspersed with brief wrap-up classroom activities to summarise key concepts and enhance students' active learning and knowledge retention.

Recommendations for future research

1. Using flipped classroom contributes to improving self-directed learning characteristics, specifically in self-concept in learning efficiency and optimistic prospect. Therefore, the flipped classroom should be further applied in other years and classes with larger sample size to enhance generalizability and increase the statistical power of the results.

2. Although the flipped classroom approach can enhance students' performance on final examinations, no significant differences were observed in pretest and posttest scores among second-year nursing students when only true-false questions were used. To improve this, future studies should employ varied quiz formats to more effectively assess higher-order thinking and the application of knowledge.

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